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Insights

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Two decades of plant diversity research:

Supporting MNR's goals for sustainable forest management, biodiversity, invasive species, and more

By Lisa J. Buse

Ask anyone if piping plovers or polar bears are important, and you'll hear a resounding "yes," but what about the importance of plants? They are key to maintaining ecosystem stability; provide food and habitat for birds, bears, and other wildlife; and are essential for human survival. However, many plants are endangered due to urbanization and other land use changes, pollution, unsustainable practices, the spread of invasive alien species, and climate change. As the 2010 International Year of Biodiversity draws to a close, we reflect on some of OFRI's plant diversity research that will contribute to *Ontario's Biodiversity Strategy*.

While boreal forests are less diverse than others due to a cold climate and short growing season, they do support more than 1,200 plant species. Understanding this diversity is a first step in determining how forest practices might affect it and how to minimize effects.

Photo: John Winters, OFRI

Forest ecology specialist Jennifer Dacosta assesses species diversity and crop tree stocking on one of the eight NEBIE study sites, where researchers are documenting the effects of various intensities of silviculture on forest ecosystems.

OFRI researcher Wayne Bell has spent much of the past two decades working with partners to understand and document plant diversity in Ontario's forests. He says, "In addition to learning what's out there, much of our effort has gone into understanding these plants and their traits – how they regenerate, where they grow, what affects their growth and development, how they interact with other plants and animals, and how they respond to disturbances such as fire and forestry practices."

Bell's Plant Ecology, Diversity, and Early Succession Program (PEDS) is dedicated to understanding plant diversity and has five components:

- Understanding the ecology of Ontario's forest plants
- Developing and maintaining an inventory of those plants
- Developing a plant trait database
- Monitoring long-term plots to determine disturbance effects
- Actively managing for non-timber forest products

Understanding basic plant ecology

Bell began looking at plant ecology in 1988. Under the guidance of Bill Towill, now science and technology coordinator with MNR's Northwest Science and Information Section in Thunder Bay, Bell reviewed the ecology of 18 species that compete with conifers in northwestern Ontario. Since then, several others have reviewed and synthesized information on over 200 other species, including ones that are rare or invasive. Understanding basic plant *autecology* – the relationship of an organism or species to its environment – helps researchers to figure out how best to minimize and/or control the invasives and prevent further loss of at risk species.

Such reviews also help to identify information gaps. For example, lichens are an important food source for caribou, but the synthesis work revealed that little is known about how lichens respond to herbicides. As a result, Bell set up a study to determine lichen tolerance to herbicides, which is being carried out by the University of Guelph's Troy McMullin and Steve Newmaster.

Bell and Newmaster are also leading the writing of a book summarizing the autecology of Ontario's plant species, which will be available through the University of Guelph in 2011. It will interest not only forest managers but also those involved

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in pit and quarry rehabilitation and right-of-way corridor maintenance, wildlife managers, students, those who harvest wild plants, and gardeners interested in native plants.

Other contributors to the book are Maureen Kershaw, a consultant in Sudbury, ON; Cathy Bentley (formerly with MNR); Fred Pinto, MNR's Southern Science and Information Section; Ngaire Eskelin and Jennifer Dacosta, OFRI; Troy McMullin and Andy Gordon, University of Guelph; Steven Hart and Nancy Luckai, Lakehead University; and Kathleen Brosemer, formerly with Forest Genetics Ontario.

Documenting what grows in Ontario's forests

In the mid-1990s, MNR's vegetation management, ecological land classification, and growth and yield programs called for an inventory of Ontario's plants, a library of plant samples or *herbarium* to use for reference, and consistent naming conventions.

At the time, Bell worked with MNR colleagues Jim Hayden (then with the Growth and Yield Program) and Peter Uhlig (with the Ecological Land Classification [ELC] Program) to compile the first edition of the *Ontario Plant List*. Now ELC staff work with Newmaster to maintain this list, which is available through MNR's Natural Heritage Information Centre within their Biodiversity Explorer (biodiversityexplorer.mnr.gov.on.ca) and includes 4,049 plants, 533 mosses, 730 lichens, as well as the University of Guelph's FLORA Ontario – Integrated Botanical Information System (uoguelph.ca/foibis/), which includes 5,039 species.

> ***It is the range of biodiversity that we must care for – the whole thing – rather than just one or two stars.***
>
> ~David Attenborough

As well, Newmaster and Bell encouraged the establishment of an educational herbarium for students of Sault College and the development of the Northern Ontario Plant Database (NOP) (northernontarioflora.ca), led by professor Sue Meades, now retired from Algoma University. Bell's field staff continue to add specimens to the latter collection.

"Both products provide baseline knowledge of which species grow where and help to ensure consistency in identifying and naming Ontario plants," Newmaster says. "In doing so, we filled a key void in Ontario's plant diversity work."

Compiling information about plant traits

"A plant trait approach allows us to scale up what we know about the autecology of individual species into a global understanding of their role in crucial ecosystem processes," explains Isabelle Aubin, a Canadian Forest Service-Great Lakes Forestry Centre research scientist with whom Bell is working. "Developing and applying a plant trait database not only to helps us optimize forest management practices but also maintain the functional, structural, and species diversity on the landscape."

She adds that emphasis on forest sustainability has increased in recent years, so this optimization has become even more important. "Looking at the functional traits of groups of similar plants can help us to model how a species community will react to a specific disturbance based on universal characteristics, such as seed dispersal mode or shade tolerance. For example, plant functional classifications were proposed in the early to mid-1990s as a tool to model changes in vegetation and ecosystem function caused by changes in climate and carbon dioxide."

Bell will contribute to Aubin's plant traits of Canada database and learn from her how to incorporate the information into his current research on the effects of disturbance on plant communities. Their plant trait work will contribute to international databases – such as TRY (try-db.org) – that are being compiled and used in global efforts to model plant community responses to disturbance and climate change.

Monitoring long-term response to disturbance

Monitoring long-term plots is key to detecting the loss of or new species, Bell says. Since the early 1990s, he and Newmaster have been working with several colleagues and partners to document plant diversity in Ontario's boreal forests. From long-term monitoring of over 10,000 plots in 20 studies, they've documented the effects of using vegetation management alternatives, intensifying silviculture, and harvesting biomass.

Bell reports, "In the NEBIE Plot Network, a study of the effects of silvicultural intensities on eight forest types, we've had sites with as few as 77 plant species or as many as 256. Clearly, forest management practices can both increase and decrease diversity."

For details about the NEBIE project, see *Insights* Vol. 8 No. 1. Formal results from this work will be available by 2012.

Managing for non-timber forest products

Bell says one of the next steps is to apply what they've learned to managing for non-timber forest products and wildlife habitat. For example, through a partnership with Tom McLean, Nipissing Forest Resource Management, Inc., and OFRI's Tom Noland, researchers planted Canada yew at the North Bay NEBIE site to document the feasibility of co-producing timber and a non-timber forest product. (Canada yew is a source of anti-cancer agents.)

In addition to discovering more about native plants, their research has allowed them to document which invasive alien plants are growing in boreal forests. The section on invasive plants in MNR's soon-to-be released *2011 State of the Forest Report* is largely based on information from their studies.

"My partners and I have been collecting the building blocks of understanding plant diversity for years," Bell notes. "Now we can start to put them together and apply this knowledge to our advantage in research and management to minimize the effects of human activities."

Bell's collaborators on long-term monitoring of effects of management practices on plant diversity and response to disturbance: Steve Newmaster and Troy McMullin (University of Guelph); Isabelle Aubin (Canadian Forest Service); Nancy Luckai and Azim Mallik (Lakehead University); Jennifer Dacosta, John Winters, Andrée Morneault, and Bill Towill (MNR); and Sue Meades (Algoma University-retired).

Want to read more? E-mail information.ofri@ontario.ca or call (705)946-2981, ext. 4111 (specify electronic or paper):

- *The effects of silvicultural disturbances on phanerogam diversity in the boreal-mixed wood forest* (Canadian Journal of Forest Research 2002)
- *The effects of silvicultural disturbances on cryptogam diversity in the boreal-mixed wood forest* (Canadian Journal of Forest Research 2002)
- *Effectiveness of delayed brush cutting and herbicide treatments for vegetation control in a seven-year-old jack pine plantation in northwestern Ontario, Canada* (Silva Fennica 2002)
- *Restoration of floral diversity through plantations on abandoned agricultural land* (Canadian Journal of Forest Research 2006)
- *Do tree-level monocultures develop following Canadian boreal silviculture? Tree-level diversity tested using a new method* (Biodiversity Conservation 2007)
- *Long-term effects of intensive silvicultural practices on productivity, composition, and structure of northern temperate and boreal plantations in Ontario, Canada* (Forest Ecology and Management 2007)
- *Effects of forest floor disturbances by mechanical site preparation on floristic diversity in a central Ontario clearcut* (Forest Ecology and Management 2007)
- *Influence of microhabitat on bryophyte diversity in Ontario mixedwood boreal forest* (Canadian Journal of Forest Research 2008)

Growth and yield modelling research: Improving predictions for Ontario's future forests

By Lisa J. Buse

How much wood is in Ontario's forests today and how much will be there decades from now? Resource professionals need answers to these questions to ensure Ontario's wood supply is stable and to allocate wood available for harvest. To get the answers they often use models.

Individual tree models are the building blocks for developing and applying most stand level growth and yield models, so the more accurate they are, the better the stand level models will predict how much wood will be available.

OFRI growth and yield modelling researcher Mahadev Sharma is dedicated to developing and improving models for estimating wood volume of individual trees. He is focusing on models of:

- **Tree shape**, referred to as *taper equations* or *stem profile models*, used to describe stem shapes
- **Growth rate**, known as *height and diameter growth models*, used to indicate how fast trees are expected to grow
- **Growth potential**, also termed *site index models*, used to indicate expected site productivity

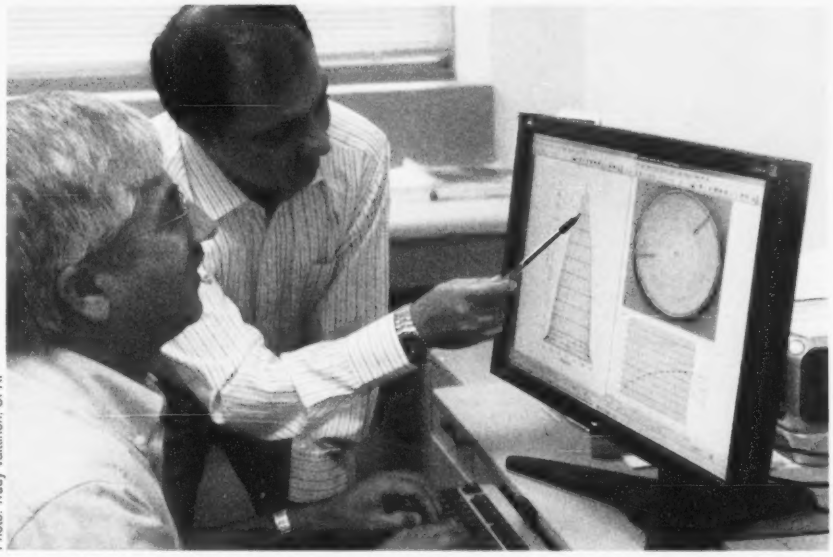

Photo: Trudy Vaittinen, OFRI

OFRI modelling researchers Mahadev Sharma and Nirmal Subedi discuss developing height growth trajectories and reconstructing whole trees using stem analysis data from scans of tree cookies.

Shape matters

Tree shape affects the amount and types of timber products that can be produced from a stem. Two trees with the same height and volume but different shapes can vary greatly in the types of products they can be used to produce, which affects their economic value. *Taper equations* – mathematical models that describe tree shape – are useful for estimating tree volumes and product yields. Sharma is factoring tree density into taper equations.

"Stand density can affect tree taper, but this variable was not previously considered in taper functions," he explains. "To increase the accuracy of tree and stand volume estimates, I am developing taper equations for plantation-grown trees that do account for density."

Sharma and John Parton of MNR's Ontario Terrestrial Assessment Program (OnTAP) looked at the effect of density on the taper of plantation grown black spruce and jack pine. They also evaluated several taper models and calibrated those using data on tree diameter taken at varying heights along the stem. Their results confirm that stand density affects stem taper and affects jack pine more than black spruce. As well, they found that basal area per hectare is a better predictor of stand density effects on taper than are number of trees per hectare and quadratic mean diameter (diameter derived from average cross-sectional area of the trees in a stand).

Read a profile about Mahadev Sharma on Page 5!

Sharma is also looking at how to reduce the costs of collecting data for taper models since costs increase with the number of measurements. He and his research collaborator Peter Newton, Canadian Forest Service-Great Lakes Forestry Centre (GLFC), evaluated scenarios to determine what to measure and where on a tree to develop an accurate taper equation at minimal cost. He is also studying how many trees to sample to model stem taper accurately for a given species. "Initial results of this work are published, but we are still refining our recommendations," Sharma says.

Height matters, but it's hard to measure

Being able to model tree growth rates is key to predicting how much wood will be available in the future. Developing and using such models requires information on diameter at breast height (DBH) and tree height. Technicians can easily measure diameter but tree height is relatively complex, time consuming, and expensive to measure. As a result, they often measure diameter for all sample trees, but measure height only for some. Researchers then estimate heights of the remaining trees based on known height-diameter relationships.

"Several height–diameter models had been developed for Ontario species using only DBH as the predictor variable for estimating total height," Sharma explains. "However, the relationship between the diameter of a tree and its height varies by species, stand, and growing environment. For example, trees in dense stands generally have smaller diameters for their height than those in open stands. To accurately estimate the height of trees, height–diameter models must reflect the range of variation in stand conditions."

To avoid establishing individual height–diameter relationships for every stand, Sharma generalized the models by adding predictor variables. He focused on models for eight commercial tree species (balsam fir, balsam poplar, black spruce, jack pine, red pine, trembling aspen, white birch, and white spruce) in Ontario that incorporate stand density information. These models can be used to accurately predict heights. In addition to height, diameter growth must be estimated to predict tree volume growth over time. Sharma is now working to develop models to predict diameter growth for plantation grown jack pine and black spruce.

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"FPInnovations-Forintek is using the height-diameter and taper equations to maximize product recovery from harvested trees," Sharma says. "And, my GLFC colleague Peter Newton is using these models to develop stand density management diagrams, which help us estimate the amount of wood in forest stands and evaluate harvesting scenarios. This information can help resource managers decide what to do with their stands: harvest now, conduct partial harvests over time, thin and harvest later, or apply some other silvicultural strategy."

Ultimately, researchers want to predict growth potential

In forestry, *site index* is the average height of dominant and codominant trees at a specified age, known as *index age*. It is commonly used to evaluate forest site productivity.

Sharma worked with OFRI's Nirmal Subedi and Parton to evaluate the predictive accuracy of published site index equations for young plantation-grown black spruce and jack pine. They found that *generalized algebraic difference approach-based dynamic* site index models, which are not dependent on *base* age (reference age), were more accurate than models that were *base age specific* (height prediction depends on the base age used to calibrate the models) and *base age invariant* (height prediction is independent of the base age used in calibrating the models). While these results are mainly of interest to modellers, they indicate the importance of choosing the correct approach when using predictive models.

One issue with existing growth and yield models is the assumption that site and climatic conditions will remain static over the prediction timeframe. "To increase the accuracy of site index models, site parameters and climate variables might need to be included," Sharma says. "My partners and I are now working to do just that. Results are expected within the next year or so."

For his modelling work, Sharma relies on data collected through MNR's forest resources inventory group as well as from growth and yield plots coordinated by OnTAP staff. Other partners include staff with MNR's science and information units and Centre for North Forest Ecosystem Research, the Canadian Ecology Centre-Forestry Research Partnership, Virginia Polytechnic Institute and State University, and Lakehead University.

For more information, contact Mahadev Sharma, mahadev.sharma@ontario.ca, (705)946-7407.

Read more about OFRI's growth and yield modelling...

- *Evaluating height-age determination methods for jack pine and black spruce plantations using stem analysis data* (Northern Journal of Applied Forestry 2010)
- *Modeling stand density effects on taper for jack pine and black spruce plantations using dimensional analysis* (Forest Science 2009)
- *An evaluation of site index models for young black spruce and jack pine plantations in a changing climate* (Climate Change Research Report 2009)
- *Evaluation of sampling design on taper equation performance in plantation-grown* Pinus banksiana (Scandinavian Journal of Forest Research 2008)
- *Height-diameter equations for boreal tree species in Ontario using a mixed-effects modeling approach* (Forest Ecology and Management 2007)

For copies of reports/articles, contact information. ofri@ontario.ca, (705)946-2981, ext. 4111.

Climate affects how nutrients move through boreal mixedwood riparian zones and peatlands

By Lisa J. Buse

Photo: Bill Cole, OFRI

Research technician Adam Kinnunen packages a peat core sample near White River for future analysis in the lab.

Riparian zones are the areas where forest and water meet. They are important because what happens in them can affect water quality. *Peatlands*, areas of accumulated organic matter known as *peat*, can also occur where land and water meet, and their processes also affect the quality of nearby water bodies.

OFRI researcher Jim McLaughlin is investigating how climate affects cycling of nutrients such as carbon and nitrogen in riparian and peatland ecosystems. Nutrient cycling is important to understand because changes in soil and water nutrients can lead to changes in the area's ability to support trees, plants, and wildlife habitat. What McLaughlin and his colleagues learn will help MNR develop policies for sustainable management of riparian zones and peatlands and feed into Ontario's state of the forest reports.

Among other things, McLaughlin has determined that nutrient cycling differed between a climatically normal and a dry year and among riparian zone types, based on information from a northern Ontario watershed near White River. Many complex interactions drive these systems, but it appears that in a warmer, drier climate, these areas may become increasingly acidic.

For details about these studies, e-mail information.ofri@ontario.ca and request:

- *Boreal mixedwood watershed riparian zone cation cycling during two contrasting climatic years* (Soil Science Society of America Journal 2009)
- *Alkalinity and acidity cycling and fluxes in an intermediate fen peatland in northern Ontario* (Biogeochemistry 2009)
- *The importance of water table in controlling dissolved carbon dynamics along a fen successional gradient* (Soil Science Society of America Journal 2010)

By Abigail M. Obenchain

Accept the challenges so that you can feel the exhilaration of victory.

~George S. Patton

This quote rings true with OFRI's Mahadev Sharma, a forest growth and productivity research scientist, who loves a challenge. Modelling forest growth and productivity certainly qualifies as challenging, as it involves developing mathematical equations to represent natural processes, such as how forests or individual trees grow and change over time. These models help those who manage Ontario's forests to estimate and ensure a steady supply of wood for Ontario's mills.

Despite the complexity and challenges of this work, Sharma believes it is an exciting time to be a modeller. "The advances in computer technology over the past 20 years have greatly improved our ability to develop models to predict future forest growth and change," he says. "The computers and software we have at our disposal today can allow more complex analyses than were imaginable just a few decades ago."

However, he points out that it is important to be aware of the limits of each model. "Models are only as good as the data on which they are based," he stressed. "Proper data is critical to the quality of the model, and it can be expensive and time consuming to collect."

Sharma has been working on a variety of models since he arrived at OFRI in 2004, including ones focusing on tree shape (taper equations), growth rate (height and diameter growth models), and growth potential (site index models), particularly under expected climate change. (For more about these models, see the related article on growth and yield modelling on Page 3.)

Sharma notes that one of the reasons he enjoys working at OFRI is because of all the helping hands around him. "People here are very friendly and willing to help. I also like the environment, which is conducive to conducting research."

He also speaks highly of his research partners, not just those at OFRI but also those with MNR's Ontario Terrestrial Assessment Program, MNR's Centre for Northern Forest Ecosystem Research, and the Canadian Forest Service.

Sharma began his academic career at Allahabad University in India, where he received his undergraduate degree in science. He taught at a high school for three years and went on to pursue a master's degree in physics at Tribhuvan University in Nepal. He then taught at the Institute of Forestry in Nepal for five years.

To continue his education, Sharma moved to the United States, where he earned master's degrees in both forestry and statistics and a PhD in forest biometrics at Virginia Polytechnic and State University in Blacksburg. Before coming to OFRI, Sharma was a research scientist at FP Innovations-Forintek in Sainte-Foy, Québec, where he conducted growth and yield research.

With his extensive academic background and notable work ethic, Sharma is a valued member of the OFRI team. Outside of OFRI, he enjoys jogging and working in his garden.

For more information about his work, contact him at mahadev.sharma@ontario.ca, (705)946-7407.

Climate envelopes are moving – will Ontario's trees be left behind?

By Ngaire Eskelin

We know it's best to plant tree seed in places with climatic conditions similar to those where the seed tree naturally originated, because trees from that seed will be genetically suited to those conditions. However, if the climate continues to change as expected, tree seed will become increasingly less suited to where it originated. Climate envelopes are shifting, and it's unlikely Ontario's tree species can keep pace. They might need a lift in the form of *assisted migration*: moving a population to a new area due to reduced climatic suitability of the previous area.

In 2008, a team of OFRI researchers (Bill Parker, Pengxin Lu, Steve Colombo, and I), in consultation with MNR's Forest Health and Silviculture Section, the Canadian Forest Service and Lakehead University, began a project to improve understanding of how quickly Ontario's tree species can adapt to climate change to support decisions related to assisted migration. We are asking:

- How will increasing temperatures/shifting climate envelopes affect tree growth, productivity, and wood quality?
- Which tree populations will be best adapted to expected future climate in a given location?
- Is planting southern tree populations further north the best approach to maximize tree survival and growth?

Some of our accomplishments to date:

- Completing a literature review on genetic variation in climatic response of selected ecologically and commercially important tree species in Ontario, which will be published in 2011 as an MNR Climate Change Research Report
- Hosting a workshop on assisted migration in Sault Ste. Marie in September 2009, during which participants presented related research and discussed the problem's scope as well as opportunities for collaboration

We are now working with the USDA Forest Service Northern Research Station (NRS) to remeasure a historical white pine *provenance* study – a test of the growth of trees from seed from throughout a species' range – set up in 1958 as part of a larger initiative by the International Union of Forest Research Organizations. Although these trials were not intended for climate change research, they cover a range of climatic conditions and will allow us to compare growth of trees from various seed sources at multiple plantation sites with data on climate conditions over time, which will help us determine which populations will grow best where and how far we can move seed sources.

Photo: Abigail M. Obenchain, OFRI

Research forester Ngaire Eskelin labels a white spruce seedling for a provenance test.

Only 12 sites are intact; with the NRS, we will remeasure seven of the sites in Ontario, Minnesota, Wisconsin, Michigan, and Maine, all containing trees from 12 common seed sources. Growth and survival measurements will be used to estimate productivity and carbon storage, and the USDA-FS Southern Research Station will assess wood properties to predict the response of wood quality to changes in climate.

Here at OFRI we are also conducting a controlled environment study examining growth response of white spruce seedlings from nine seed sources to a range of temperatures. We hope to learn whether this relatively short experiment can help us determine the optimum summer temperatures for seedlings from various Ontario sources to help determine where to plant them under future climates.

Results of these and other planned studies will contribute to developing policy for assisted migration that weighs potential benefits and risks so MNR can ensure well-adapted forests regardless of future climate.

For more information about this research, contact Bill Parker, bill.parker@ontario.ca, (705)946-7424.

OFRI research forester diagnoses tree diseases to support provincial forest health monitoring

By Abigail M. Obenchain

If you tour the forest pathology lab at OFRI, you will quickly learn that long-time pathology research forester Sylvia Greifenhagen is fascinated by forest fungi. As she points out, they make up a remarkably diverse biological kingdom, taking a range of forms, colours, shapes, textures, and functions. While some are tasty sauteed in butter, others can damage or even kill trees. Some can even kill people.

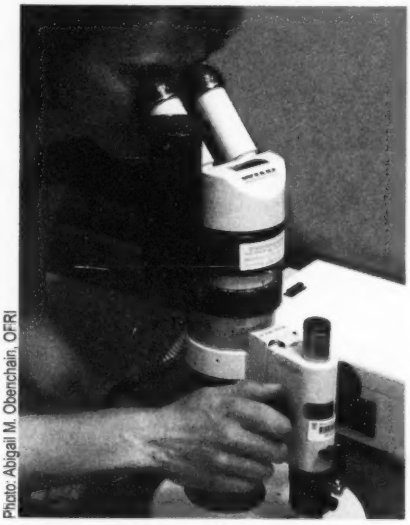


Photo: Abigail M. Obenchain, OFRI

OFRI's Sylvia Greifenhagen identifies fungi that cause tree diseases based on samples collected by staff with MNR's Forest Health Monitoring Program.

Greifenhagen has enjoying learning even more about Ontario's forest fungi, recently wrapping up her second season of lending her diagnostic experience to Ontario's Forest Health Monitoring Program, part of MNR's Science and Information Branch.

Over the past few years, this program has gone through major changes as it evolved from a mostly federal to mostly provincial responsibility, with 2009 being the first year it was led solely by MNR. Greifenhagen is responsible for identifying diseases from samples collected by MNR's forest health technicians, who are spread across the province (see article below for more about identifying disease fungi). Staff with the Canadian Forest Service-Great Lakes Forestry Centre continue to provide diagnostic services for insect pests and maintain the national forest pest database used by forest researchers and academics.

The busy season for forest health monitoring is mid-spring to early fall, Greifenhagen says, but work goes on all year round. For example, in winter 2010 technicians were out collecting samples from beech trees as part of a survey for beech bark disease, which is caused by an invasive alien fungus. This disease poses a serious threat to beech, an important tree for wildlife, across its range in Ontario.

In spring 2010, technicians were busy dealing with widespread frost/scorch damage to maple tree leaves across central and southern Ontario, which was caused by unusually erratic weather (very warm early, then very cold, then very warm again). According to Greifenhagen, if enough leaves are killed, a tree will flush new leaves, but that can tax its energy reserves. One year of damage is likely not serious, but if the weather continues to be erratic in the spring, it could stress the trees enough that they will be vulnerable to disease and insects.

Greifenhagen is not the only person at OFRI with forest health monitoring duties. Dan Rowlinson, coordinator for the field program, moved into OFRI early in 2010 to be closer to key colleagues.

For more information about OFRI's diagnostic support to the Forest Health Monitoring Program, contact Sylvia Greifenhagen, sylvia.greifenhagen@ontario.ca, (705)946-7411. For more information about the Forest Health Monitoring Program, contact Dan Rowlinson, dan.rowlinson@ontario.ca, (705)946-7445.

How are tree disease fungi identified?

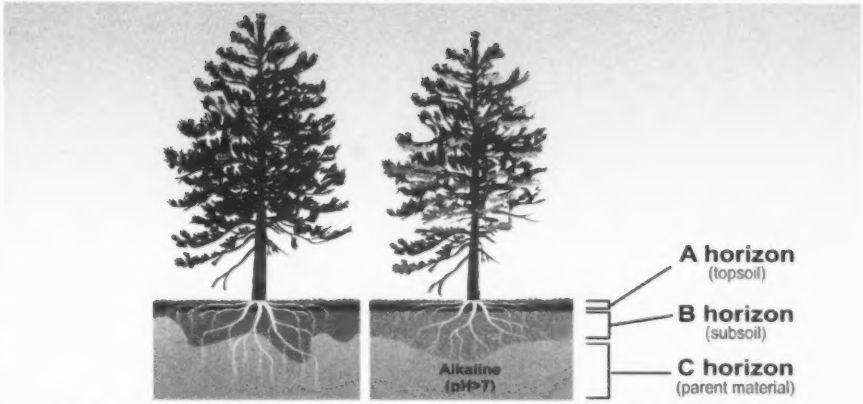
If a large fruiting body (e.g., a mushroom) is present, that's an important clue. But often disease fungi are at work inside the tree or under the soil line, so researchers must use other identification techniques:

1. Using a microscope to identify fungal structures, especially fruiting structures and spores, often by comparing them with dried and pressed samples from the herbarium at the Canadian Forest Service-Great Lakes Forestry Centre, which houses thousands of such samples

2. Culturing fungi in a petri dish and if necessary using a dichotomous key, a tool that allows the user to answer a series of paired questions that lead to the correct species name

3. Identifying the fungus by analyzing their DNA

Photos: MNR archives



Research led by OFRI's John McLaughlin has revealed that alkaline soil spells trouble for red pine plantations.

Why are southern Ontario red pines dying, and what can be done about it?

By Abigail M. Obenchain

If you drive through southern Ontario, you will see many patches of mature red pines. These trees were planted beginning early last century to help jumpstart the restoration of areas cleared for farming but then abandoned due to poor soil. Where the forest was removed, the thin layer of topsoil often blew away, leaving desert-like conditions. (See ontario.ca/ofri for more on Ontario's blowsand areas.)

As the decades passed, the planted red pines thrived and began yielding benefits to the people of southern Ontario: timber for telephone poles and construction, scenic sites for hiking and crosscountry skiing, and more. Understory plants and wildlife moved in and flourished.

In the late 1990s, foresters in southern Ontario saw that more and more mature red pine were rapidly declining and dying. In some areas, mature red pines were toppling over with their foliage still green, causing economic losses to landowners hoping to harvest those trees and safety hazards to those using the plantations for recreation. In addition, resource managers had hoped to convert these plantations back to natural forest over time, but the large gaps were allowing less desirable species such as Manitoba maple to dominate.

In 2003, OFRI research scientist John McLaughlin and collaborators with the University of Guelph and several counties in southern Ontario took up the challenge to determine what was causing the decline: A biological factor, such as a root disease? An environmental factor, such as increased drought? Several factors working together?

Researchers set up a network of plots on 12 sites across southern and central Ontario and collected data to compare healthy and declining stands. Their key finding: In healthy plantations, the pH of the soil C horizon (see graphic) was acidic to neutral; in declining plantations, the pH was somewhat to very alkaline. In addition, trees growing in areas with alkaline C horizons usually had shallower roots, which past research has shown predisposes them to drought stress and damage from insects and root disease.

Researchers also found that where upper soil layers (A and B horizons) are alkaline, trees are likely to start declining by age 30-40 due to iron deficiency. Even where the soil has enough iron, the alkalinity makes it insoluble/unavailable to trees, a condition worsened by drought. These trees generally have yellowing needles, reduced growth, and thinning/dying crowns.

So what do McLaughlin and his collaborators recommend for those establishing and managing red pine plantations? For starters, check the pH of the A, B, and C soil horizons of proposed red pine sites, and avoid planting where it's alkaline.

For more information, contact OFRI for a copy of Forest Research Note No. 69, entitled *Mortality in Southern Ontario Red Pine Plantations: Causes, Consequences, and Management Options;* e-mail information.ofri@ontario.ca or call (705)946-2981, ext. 4111. Please specify electronic or paper.

OFRI turns 20!

Much has changed over the years, but OFRI'S mandate holds

Since the OFRI facility officially opened in Sault Ste. Marie in December 1990, the only constant in the organization has been change – in its focus, staff, and the facility itself.

In the early 1990s, OFRI had nearly 90 permanent staff, some of whom were located in Thunder Bay and were soon transferred to what is now MNR's Centre for Northern Forest Ecosystem Research (CNFER). In those days, the focus was on large research programs associated with Ontario's Sustainable Forestry Initiative.

Today, OFRI has about 45 permanent positions, of which 14 are research scientists, with only a handful of staff from the early days. The focus has moved away from program areas to a more project-based approach driven by changing MNR priorities, which today include climate change, renewable energy, support of Ontario's forest industry, land use planning in the Far North, and invasive species/species at risk.

The OFRI facility now houses other MNR units as well as research, such as the Ontario Terrestrial Assessment Program, the Forest Resources Inventory Program, and part of the Upper Great Lakes Management Unit.

Despite these changes, OFRI's mandate has remained constant: To provide scientific leadership and applied forest research to support policy, planning guides, and operations.

To find out more about what is happening at OFRI, visit ontario.ca/ofri.

Happy birthday to OFRI!

Ontario Forest 2 Honouring twen

Honouring 20 years of forest

By Abigail M. Obenchain

The Ontario Forest Research Institute (OFRI) opened its doors 20 years ago, in December 2010, starting a new chapter in provincial forest research and sparking many discoveries.

The knowledge and tools developed by provincial researchers at OFRI continue to provide a strong scientific foundation for Ontario's forest policy, planning, and operations.

To recognize OFRI's discoveries over the past 20 years, we revisited back issues of *Insights* newsletter to spotlight some of the more memorable stories. Please note that space does not allow us to list all the partners we've worked with over the years – but we recognize that their efforts have been critical to OFRI's research success. They include MNR's policy, planning, science and information, and field staff; university and college collaborators; forest industry staff; those with other research organizations such as the Canadian Forest Service and Canadian Ecology Centre-Forestry Research Partnership; private consultants; and more.

So how much do YOU know about OFRI's discoveries? What exciting stories did you miss along the way? Read on to find out!

The below is just a sampling of advances at OFRI since 1990. If you'd like to know more or get related publications, e-mail information.ofri@ontario.ca and say which topics you are interested in.

Supporting the development of landscape-scale forest management

Staff with OFRI's Forest Landscape Ecology Program have spent 20 years researching and developing an array of computer tools for understanding forest landscapes, supporting a sea change in the way Ontario's forest managers and planners do their jobs.

These tools, which use geographic information systems (GIS), enable anyone with a PC to analyze, explore, and display massive amounts of geographic information at different scales, from forest stands to the entire province. These tools have been used to support many forest management exercises in Ontario and include:

- The GIS-based Ranking System for Pine (GRASP), which allowed users to make landscape-scale decisions about how best to conserve the province's old growth red and white pine
- The Landscape Ecologicai Analysis Package (LEAP), which resource managers use to analyze landscape pattern indices to support forest management planning requirements
- The Boreal Forest Landscape Dynamics Simulator (BFOLDS), a fire regime-succession simulation model that those involved in

emulating natural disturbance (and others) can use to explore changes in forest cover over time and space; it was used to develop the *Forest Management Guide for Natural Disturbance Pattern Emulation* as well as the forthcoming guide for managing boreal forest landscapes

Helping the forest industry by enhancing forest productivity

In 1999, MNR, environmental groups, and the forest industry signed the *Ontario Forest Accord*, which among other things called for more land to go into parks and protected areas as well as more research to enhance the productivity of forests still open to harvesting.

OFRI researchers responded to this need by launching the *Intensive Forest Management: NEBIE Plot Network* project, which has eight sites

in varying forest types across northern and central Ontario. *NEBIE* stands for the range of silvicultural intensities they are testing: natural (no human activity), extensive, basic, intensive, and elite. Results of this work are helping forest managers plan how much to invest in silviculture to produce more fibre as well as a healthy ecosystem.

Reporting on indicators of the state of Ontario's forests

Every five years, MNR is required to report to the people of Ontario about the state of the province's forests, and it does so by evaluating a set of indicators that represent the range of ecosystem components and functions. One of the many behind-the-scenes jobs of OFRI scientists is lending scientific expertise to reporting on indicators of sustainability.

For example, for the 2011 state of the forest report, OFRI researchers have written reports for indicators related to:

- Conserving biological and genetic diversity (abundance of invasive species, population size of tree seed orchards)
- Monitoring and maintaining forest productivity and resilience (net primary productivity)
- Protecting/conserving Ontario's forest soil and water resources (compliance with forest management guidelines for protecting water quality/fish habitat)
- Monitoring forest contributions to the global ecological cycle (forest carbon balance, monitoring nitrogen and sulphur deposition)
- Monitoring trends in non-timber forest resources (e.g., Canada yew)

This work is just one example of how researchers support MNR policymakers and planners.

esearch in Sault Ste. Marie

Modelling how much carbon is in Ontario's managed forests

Understanding how much carbon is moving in and out of Ontario's forests is a newer but important part of sustainable forest management. OFRI researchers have developed a model called FORCARB-ON that can be used to project how much carbon forests store overall and in various pools (live trees, leaf litter, etc.). They have estimated the current size of Ontario's managed forest carbon stock at more than 6 billion metric tonnes. They have also projected an increase in combined carbon stocks in Ontario's managed forests and harvested wood products throughout the 21st century (under an assumption of status quo in factors affecting forest growth and management). Their work will help identify management practices to maintain forest carbon while providing a sustainable supply of wood products.

Improving predictions of Ontario's future forests

To support the forest industry in Ontario, MNR must know how much wood is in the forests today and how much will be there in future decades. Over the last 20 years, OFRI researchers have developed or improved existing computer models to answer a range of questions about forest growth and yield. For example, they worked closely with American researchers to develop a single method to estimate the wood volume of trees in a forest stand and the types of products those trees can be used for, providing a common base for discussions during the softwood lumber dispute. They have also improved models that describe the shape of trees in boreal forest plantations to improve estimates of wood volume and product yields. In addition, they have improved the accuracy of tree height-diameter models, which help resource professionals determine how much trees will grow over time, also critical information for the forest industry. (See related article on Page 3.)

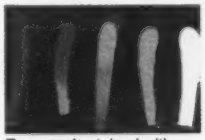
Determining the role of ancient logs in shoreline ecosystems

In the mid-1990s, forest and aquatic researchers joined forces to better understand how shoreline trees become logs in the water and what they contribute to shoreline ecosystems (*riparian zones*). What they discovered was big news: Old logs lying in the water along the shorelines of some lakes in northeastern and central Ontario can be more than a thousand years old. While the older logs mostly were white pine, the oldest was a red pine that had a pith date of about 850 A.D., lived until about 1160, fell into the water, and has been floating there ever since as part of a complex tangle of aquatic habitat.

These researchers have conducted several studies over the years, revealing new information about how coarse wood ends up in lakes, how long it persists as potential habitat in the nearshore zone, what ecological services it provides, and how natural mortality and tree fall around lakes change if you harvest only certain trees in riparian zones. Results of this research were incorporated into the *Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales*, providing new knowledge and science-based support on riparian forest management to Great Lakes-St. Lawrence forest management planning teams.

Learning that the more seedlings and seeds glow, they better they will grow

Every plant emits a pattern of red light known as *chlorophyll fluorescence*, which is not visible to the naked eye. Researchers at OFRI exposed tree seedlings to stress (high heat and low humidity) and then compared their pre- and post-stress "glows." The result: seedlings that recovered well from the stress tests – as indicated by their glow characteristics – also grew better after planting. This physiological test of seedling condition was one of several developed as part of OFRI's renowned Stock Quality Assessment Program in the 1990s and now in operational use in Ontario.



Tree seeds stained with fluorescein diacetate

Researchers also developed a test that used a glow-in-the-dark stain called *fluorescein diacetate* to determine whether tree seeds are viable. The more a stained seed glows, the more viable it is. More effective and quicker to use than previous tests, this procedure is now used by tree seed plants in Ontario.

Sensing forest condition from the air

Researchers with OFRI's Stock Quality Assessment Program knew that chlorophyll content is a useful indicator of seedling condition. But could they assess overall forest condition from the chlorophyll in the canopy? In the late 1990s, they began investigating whether hyperspectral images taken from aircraft could reveal whether a forest is under stress that might not yet be visible. These images show the amount of light of different wavelengths that plants reflect or emit. By comparing hyperspectral images with ground data on forest condition, especially chlorophyll content, researchers were able to determine how to "read" the images for signs of stress. Relatively quickly and with the aid of many partners, they were able to develop a system for assessing the condition of maple stands in Ontario. They then moved on to key boreal forest species, such as black spruce, jack pine, aspen, and white birch, with promising results.

They are now working on the more challenging task of assessing forest condition in mixed forests via both hyperspectral sensing and lidar, which uses a laser to determine spatial information about things on the Earth's surface, including trees. The goal is to incorporate hyperspectral sensing into forest resources inventory, to enable efficient, cost-effective species identification and assessment of forest condition across Ontario, which could become a more pressing concern as the climate changes.

Helping to plan and conduct a quick, holistic, and effective response to the 1998 ice storm

In January 1998, a massive ice storm damaged hundreds of thousands of hectares of forest across northeastern North America, including eastern Ontario. What happened next was a remarkable chapter in the history of interdisciplinary, inter-agency cooperation. For example, researchers and science specialists with MNR (including OFRI); the Ontario Ministry of Agriculture, Food, and Rural Affairs; the Canadian Forest Service; and universities came together quickly to plan and respond to this devastating event. Within days, they began mapping the damage, providing preliminary advice to woodlot and sugarbush managers, and planning studies to learn how best to deal with severe crown damage events, which could happen more often under climate change.

OFRI researchers co-led the Ontario science team, determining how various amounts of crown loss affected the biochemistry of maples in sugarbushes (root starch, sap production and sweetness) and strengthening the scientific foundation for guidelines for tapping damaged trees and for managing trees with crown damage. Researchers also found that trees can bounce back after a single major stress event such as a severe ice storm, but if a second such event happens soon after, decline is likely.

Transforming Ontario's blowsand areas into healthy forest

Perhaps the most remarkable ecological restoration story in Ontario's history happened in the *blowsand areas*: the many patches of land in the south that were cleared for farming a century or more ago but then lost their thin topsoil to erosion, leaving behind desert-like terrain. In the early 1900s, the provincial government worked with counties to draft laws and agreements to encourage planting conifer trees in these areas. Red pine was the tree of choice as it tolerates dry, infertile soil, and over the 20th century these plantations grew well, enriching the soil and providing cover for wildlife and other plants, recreation areas for millions of southern Ontarians, and income for governments and other owners.

Over the past two decades, OFRI researchers have worked with partners in southern Ontario to address two important issues: How can these plantations be managed to foster conversion to more natural forest, and why have some of these plantations suffered large pockets of mortality? Researchers have learned much about what conditions are needed for natural regeneration, in what situations seedlings should be planted to help ensure the right mix of trees, and how best to insure that red pines planted today do not suffer the decline and mortality affecting some existing plantations.

Sustaining Ontario's provincial tree via silviculture and genetics research

Eastern white pine has been dwindling for decades, with causes including fire suppression, historical non-sustainable harvesting practices, white pine weevil, and the invasive disease known as blister rust. Due to widespread concern about this valued tree, OFRI researchers – working with many partners but especially MNR's Southern Science and Information Section – have conducted many studies to determine how best to sustain it.

For example, they've investigated how site preparation and release from competition affect the survival, growth, and physiology of naturally regenerated and planted white pine. In addition, they have produced hybrid white pine that are over 90 percent native but appear to be able to resist blister rust, which could allow this tree to be restored to sites at moderate risk for disease. They also led the writing of a technical report that summarizes the status, challenges, and management of eastern white pine in northeastern Ontario. Transfer of results via workshops, field tours, and publications is helping to ensure new information is used in white pine management.

Closing the information gaps on managing boreal mixedwoods

Boreal mixedwood forests are complex and biologically diverse, offering a range of forest products, diverse habitat, and high resilience to natural disturbances. However, due to the relatively short history of mixedwood management and the complex interactions of multiple tree species, mixedwood forests are still a bit of an enigma. Over the past decade, OFRI researchers have been working on several projects designed to close the mixedwood information gaps.

In 2002 they adopted a stand-level adaptive management approach to grow mixedwoods using multiple silvicultural treatments and to speed the use of new information. Researchers have learned a lot about how best to achieve productive mixtures of conifers and hardwoods at operational scales and what effects those practices have on ecosystems. They also demonstrated the effectiveness of using partial harvesting to enhance conifer regeneration while reducing herbicide use. Results will be used in upcoming revisions of the *Silviculture Guide to Managing Spruce, Fire, Birch, and Aspen Mixedwoods in Ontario's Boreal Forest.*

Learning how best to control plants that compete with crop trees

Herbicides are an effective and in most cases safe tool for controlling vegetation that competes with valuable crop trees. However, to address public concerns about the use of herbicides, in the early 1990s MNR set up the Vegetation Management Alternatives Program, headquartered at OFRI. Since then, OFRI researchers have worked with many partners to produce a wealth of information on how herbicides and their alternatives affect crop trees, competitive plants, and various parts of the ecosystem. This information is helping forest managers make wiser decisions about when to use which vegetation management tool to benefit crop trees while affecting the ecosystem as little as possible. (See related article on Page 13.)

Launching a new somatic embryogenesis lab to address exotic diseases, tree quality and species at risk

A more recent advance at OFRI is the new somatic embryogenesis laboratory, set up in 2009. *Somatic embryogenesis* refers to generating masses of embryonic tissue from a single tree seed embryo or other plant tissue; these masses can then be stored frozen in liquid nitrogen for decades. From each of these masses, many (perhaps even thousands of) genetically identical trees can be produced. Researchers are now using this lab to quickly and cost-effectively replicate trees with desirable genetics traits, such as hybrid white pines that can resist the deadly blister rust fungus and white spruce that have superior growth traits. In the future, this approach could be used to conserve the genetic diversity of tree species threatened by an exotic disease until a control strategy is found.

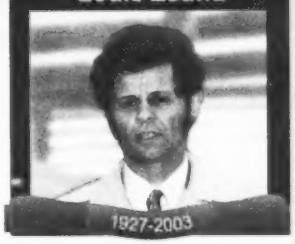
Photos: MNR archives

Ontario Forest Research Institute 20 Honouring twenty years of discovery

OFRI meeting rooms renamed to honour notable researchers of the past

The OFRI facility and name may be only 20 years old, but provincial forest research has been around for more than 65 years! As part of OFRI's 20th birthday celebration, we decided to rename our lecture pit and boardrooms in honour of four distinguished provincial researchers who made their mark in the 45 years before OFRI came to be. Their contributions to forest management were significant and have stood the test of time.

Louis Zsuffa



OFRI's lecture pit is now the Louis Zsuffa Lecture Theatre

- During his 17 years as a research scientist with the Ministry of Natural Resources (1967-1984), Louis Zsuffa gained worldwide recognition for his contributions to tree improvement and forest genetics research.
- His foundational work allowed many aspects of tree improvement in Ontario to be moved from research to practice: For example, he began Ontario's highly successful breeding program to grow poplar and willow for bioenergy plantations and was active internationally in IEA Bioenergy and the International Poplar Commission.

G. Angus Hills

OFRI's main boardroom is now the G. Angus Hills Boardroom

- During his 23 years as a research scientist with the Ministry of Natural Resources (1944-1967), Angus Hills was best known for his work on classifying, mapping, and evaluating site productivity, which resulted in the Hills site classification system that remains Ontario's standard.
- He introduced the concept of classifying sites based on physiography to support a holistic and ecological approach to land use planning, which was adopted far beyond Ontario and paved the way for the development of forest landscape planning in Canada.
- For a decade, he was Ontario's Chair of the International Biological Program for the Conservation of Natural Terrestrial Ecosystems. He also served as editor of the journal *Landscape Planning* from its inception in 1974.

Carl Heimburger

OFRI's Room 209 is now the Carl Heimburger Boardroom

- During his 22 years as a research scientist with the Ministry of Natural Resources (1946-1968), Carl Heimburger set up the province's first tree improvement program, focusing on breeding blister rust resistant white pine, developing aspen hybrids that could be grown from rooted cuttings, and perfecting techniques for breeding pine, spruce, and cedar.
- Referred to as the "father of forest genetics and tree improvement in Canada," he was one of the founders of what is now the Canadian Forest Genetics Association, which presents the Carl Heimburger Award to the best presenter at its biennial conferences.
- He also named and served as Canadian editor of the international journal *Silvae Genetica* from its inception in 1951 to his retirement in 1968. He was the first and only professional forester elected a Fellow of the Royal Society of Canada.

Chris Glerum

OFRI's third boardroom is in flux but will be renamed after Chris Glerum

- During his 29 years as a research forester and then scientist with the Ministry of Natural Resources (1959-1988), Chris Glerum gained worldwide recognition for his contributions to the development of a suite of nursery stock quality tests.
- Most notably, he developed tests to assess seedling frost hardiness using electrical impedance, improved understanding of how plant physiology affects reforestation, and was a pioneer in studying the biochemistry of forest tree species.
- He was a charter member of the Ontario Professional Foresters Association and for a decade led the Nursery Working Group of the International Union of Forestry Research Organizations.

Photos: MNR archives

Twenty years of plotting:

Researchers set out to solve the mystery of a promising but low-profile commercial tree species

By Chris Uhlig, summer experience student, and Abigail M. Obenchain

They grow just about everywhere in Ontario, but not in great numbers. They grow where little else does, but not quickly or well. They are important not only to Ontario's forest industry but also as a spiritual and cultural species for Canada's First Nations people. Those growing on cliffs in southern Ontario are the oldest trees in eastern North America (up to 1,100 years old!). The species? Eastern white cedar.

Until recently, eastern white cedar was not a major crop species in Ontario. But demand for it has always been steady, as cedar is rot resistant, making it popular for docks, decks, posts, fences, shingles, and cabin logs. However, due to its relative sparseness and soft, light wood, the forest industry has generally viewed it as a secondary species.

Photo: Lindsey Freeman, OFRI

OFRI summer experience student Tianna Burke sets up for a hemispherical photo to assess light available to regenerating white cedar.

Eastern white cedar has other important uses: It is one of the primary medicinal plants of the Ojibway people, who have used it to treat scurvy and other ailments. It is also a source of food and habitat for white-tailed deer, small mammals, and several bird species, as well as a popular landscaping tree and mulch ingredient.

Several years ago, OFRI research scientist Rongzhou Man became interested in white cedar when he noticed entire stands being clearcut and realized that information about managing this species is sparse. MNR now has a series of studies underway to address the lack of information about white cedar (see list at the bottom of the page), and Man has been part of the research since the planning began. His work focuses on how residual cedars respond to harvesting. It is unclear, for example, whether harvesting methods ensure the survival and growth of cedar *advance regeneration* (young trees left after harvest to become the next forest) in lowlands where understory cedar is generally abundant. Also unknown: whether partial harvest leaves residual overstory trees in uplands healthy enough to provide seed sources and shelter for natural regeneration.

Studying white cedar is challenging because it grows slowly, Man says. "While other species take four or five years to regenerate, white cedar takes up to 20. Slow growth and high stress tolerance mean that it takes longer for researchers to determine cedar's response to harvesting."

Researchers will assess the study plots every five years as the trees continue to grow, but conclusive results will likely take 20 years.

If you'd like to learn more about OFRI's white cedar work, contact Rongzhou Man, rongzhou.man@ontario.ca, (705)946-7484.

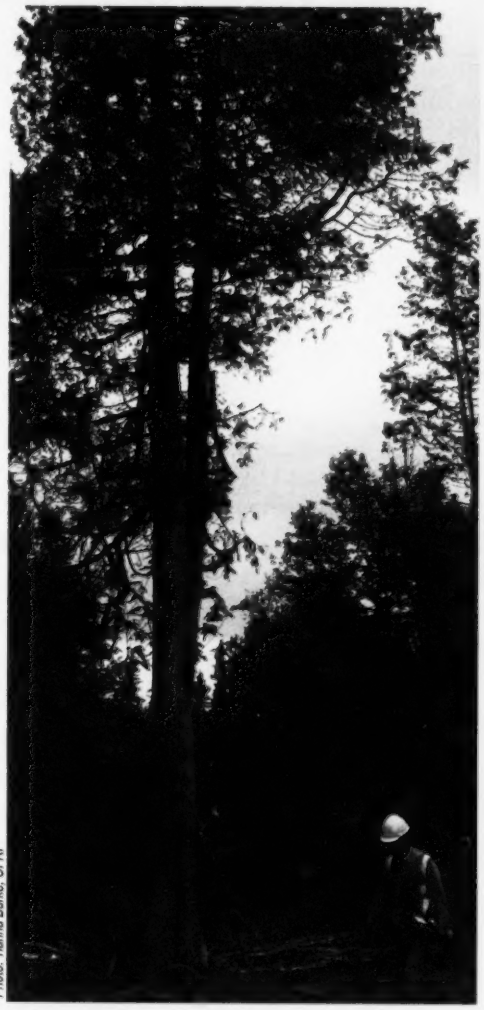


Photo: Tianna Burke, OFRI

OFRI researchers are looking at how harvesting affects eastern white cedar residuals *(those left after harvest) in northeastern Ontario. Interest in cedar as a crop species is on the rise.*

Who else in MNR is studying eastern white cedar?

Rongzhou Man's eastern white cedar study is part of a larger framework of MNR research designed to fill information gaps related to this species. Other studies include:

- Developing a monitoring protocol to assess regeneration success – Gordon Kayahara, Northeast Science and Information Section
- Measuring cedar tree form, stand yield, and ecological relationships – Dan Corbett, Northwest Science and Information Section
- Assessing planted stock perfomance on competitive upland sites and evaluating seed dispersal from residual trees and/or edges – Nick Buda and Doug Reid, Centre for Northern Forest Ecosystem Research (CNFER)
- Conducting screening trials to determine which forest herbicides eastern white cedar can tolerate – Nancy Cain of Cain Vegetation and Michael Irvine, Forest Health and Silviculture Section

Researchers hope that their efforts will help maintain healthy productive cedar stands, supporting the needs of forest industry as well as protecting ecological and cultural heritage values.

What have we learned about releasing conifers from competition? Synthesizing 20 years of research

By Lisa J. Buse

Over the past few years, OFRI researcher Wayne Bell, Lakehead University's Nancy Luckai, and the Canadian Ecology Centre-Forestry Research Partnership's Al Stinson and Sue Pickering have co-led a project with partners from British Columbia, Ontario, Quebec, and New Brunswick to summarize what is known about methods to control vegetation that competes with conifers.

These researchers have been looking at not just the environmental consequences of using various vegetation management treatments but also the social and economic implications of conifer release at the stand and landscape levels. They have focused primarily on results of studies in Ontario's managed forests begun during the early 1990s under MNR's Vegetation Management Alternatives Program but have also reviewed results from other studies across Canada.

"We wanted to pull together all the work that has been done over the past two decades," Bell explains. "Individual projects have been reported on in various places, but the information was scattered and needed to be summarized and made accessible to practitioners. The goal is to help forest managers choose the most effective treatment for their sites and circumstances."

He points out that vegetation management helps direct light, water, and nutrients towards crop trees to improve their survival and growth. "Forest managers choose treatments based on a combination of the autecology of the site's competitor species, management objectives, and other values, as well as environmental and socio-economic considerations."

Al Wiensczyk and Kathie Swift, of FORREX (Forum for Research and Extension in Natural Resources), a not-for-profit organization in British Columbia, have been key players in summarizing the literature to determine what's known about the silvicultural effectiveness and ecological effects of various treatments. Wiensczyk explains that treatment options can be categorized into:

- Harvest systems and physical: site preparation, brushing, girdling, mulching
- Thermal: fire, steam
- Cultural: seedling culture, cover crops, grazing
- Chemical and biological spray treatments

"These reviews have been based partly on information from the *Canadian Forest Management Database* set up and maintained by Dean Thompson, Natural Resources Canada, and co-sponsored by the Canadian Ecology Centre-Forestry Research Partnership," Wiensczyk says. "This database contains about 14,500 citations relevant to forest management in Canada, particularly controlling competing vegetation, insects, and diseases."

When asked to share some of the findings to date, Lakehead University graduate student and former OFRI intern Krishna Homagain reports: "Herbicides are still the most cost-effective alternative we have. For example, tenth-year results from one of our biggest studies, the Fallingsnow Ecosystem Project, show that brushsaw and mechanical brush cutter treatments cost three times as much as herbicide per cubic metre of wood volume."

Researchers Stephen Wyatt, Université de Moncton, and Marie-Hélène Rousseau, Université Laval, are summarizing the social issues related to vegetation management alternatives. They have proposed a framework within which to evaluate public concerns and stress that people view and accept vegetation management alternatives based on context, risk, aesthetics, trust, and knowledge. They caution that people's acceptance of alternatives can change over time and among situations and they perceive risk based not just on science but also values, concerns, and trust in decisionmakers and resource managers.

Photos: John Winters, OFRI

As part of the search for viable alternatives for releasing conifers from competition, researchers conducted studies across northern Ontario to evaluate the effectiveness of alternatives such as motor-manual and mechanical cutting systems and their effects on ecosystems. Results of these long-term studies are presented in several publications including a spring special issue of The Forestry Chronicle.

"Regardless of method, early release treatments generally result in more conifer fibre in the long term," Bell says. "The trick is getting a combination of treatments that ensures we achieve the long-term objectives for a given site."

According to Eacom Timber Inc. (formerly Domtar) biologist and research team member Kandyd Szuba, based in Espanola, ON, the landscape-level case study analysis focused on the longer-term consequences of various release alternatives within the framework of forest management plans (FMPs). The wood supply models used for this analysis represented two MNR-approved FMPs (including all objectives and ecological constraints): for the Spanish Forest (non-spatial SFMM analysis) and for the Romeo Malette Forest (spatial Patchworks model).

Working with Szuba is OFRI forest research ecologist Jennifer Dacosta, who reports: "In our case studies, reducing herbicide use resulted in less area harvested, less spruce-pine-fir wood volume harvested, lower net revenue to the Crown, a larger network of active roads, and higher cost to maintain roads and haul wood. But it produced more old growth forest – more than needed to meet ecological targets; more habitat for wildlife preferring mature and old forest, such as black-backed woodpecker; and less habitat for wildlife species preferring young or recently disturbed forest, such as kestrel, moose, and white-throated sparrow."

So how are the researchers sharing their findings? Project partner John Pineau of the Canadian Institute of Forestry (CIF) says, "We are now transferring the results via regional workshops, presentations, the CIF lecture series, and articles in a special issue of *The Forestry Chronicle* in March/April 2011 to get this information out to as many resource managers as possible."

Partners in the synthesis project are Lakehead University, the Canadian Ecology Centre-Forestry Research Partnership, Canadian Institute of Forestry, FORREX, Eacom Timber Inc., Tembec Enterprises Inc.-Forest Resource Management Group, Spatial Planning Systems, Université de Moncton, Université Laval, Canadian Forest Service, Québec Ministère des Ressources naturelles et de la Faune, University of Guelph, and the National Council for Air and Stream Improvement-Canadian Operations.

For more information, contact Wayne Bell, wayne.bell@ontario.ca, (705)946-7401. To receive copies of related papers, e-mail information.ofri@ontario.ca.

How could climate change and human activities affect food available to woodland caribou?

By Abigail M. Obenchain

In Ontario, the woodland caribou has been declared a threatened species under the *Endangered Species Act*. Through *Ontario's Woodland Caribou Conservation Plan* and the *Recovery Strategy for the Forest-Dwelling Boreal Population of Woodland Caribou in Ontario*, MNR has committed to ensuring that policies for conserving caribou are based on sound science.

As is the case with many natural resources, experts know a lot about what caribou need to survive and thrive, but information gaps exist. One question that a group of researchers at OFRI is hoping to answer: How could expected changes in climate as well as mining/forest management activities affect plants that caribou eat and thus their recovery/conservation?

Led by Tom Noland and including OFRI's Maara Packalen and Glen Brown of MNR's Ontario Terrestrial Assessment Program as well as University of Guelph researcher Merritt Turetsky, this group has set up plots at three peatland sites near Cochrane. In summer 2010 they collected baseline data about plant communities and peat and water conditions at these sites, and in 2011 they plan to change the peatland water levels to simulate the kind of changes that might happen during mining or forestry activities or under climate change.

"We have three main goals," Noland says. "One, we want to cause the kind of changes in water table position that are likely to occur with mining activities or climate change and then determine how those changes affect the quality and quantity of spring and summer forage for caribou. By quality, we mean attributes such as digestibility as well as the amount of fibre, nitrogen, protein, carbohydrates, and micronutrients.

"Two, we want to describe the implications of forage quality changes; for example, if the changes we expect due to climate change affect when plants start growing and how much water they get, could that in turn affect caribou condition and calving success?

"And finally," he concludes, "We want to strengthen the scientific foundation for MNR's caribou management policy, to ensure that it does the best possible job of protecting the integrity of the ecosystems in which caribou forage."

Researchers expect results in about three years; they want to keep the water level low for two years to see cumulative effects on plants. However, they also hope the study will lead to a long-term research station for monitoring the effects of water table position on belowground features, plant community response, and *trace gas* dynamics (the movement of gases that make up less than 1 percent of the Earth's atmosphere through soil, water, and the atmosphere). While these gases are relatively low in concentration, they play an important role in climate change, and understanding their dynamics is important to understanding the effects of climate change and human activities on ecosystems.

Photo: Maara Packalen, OFRI

OFRI summer experience student Erin Mallinger takes a pH reading at a caribou forage research site north of Cochrane.

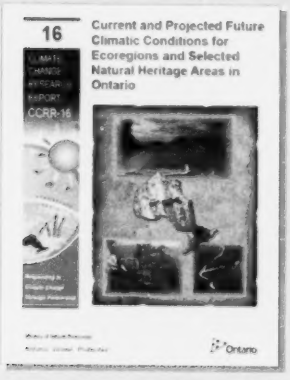
For more information about the plant aspects of this study, contact Tom Noland, tom.noland@ontario.ca,(705)946-7421. For more about the caribou aspects, contact Glen Brown, glen.brown@ontario.ca, (705)946-7409.

Will Polar Bear Provincial Park be growing maple in 2100?

By Abigail M. Obenchain

If the climate changes as expected over the next century, the *climate envelope* (area of suitable climate) for many of Ontario's plant and animal species will likely shift, in some cases dramatically. Some ecosystems and species could get lost in the shuffle.

To help ensure that Ontario's ecosystems and species are sustained as much as possible, resource managers need to know *how* the climate will change at various scales. Two scales of key interest are: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Current and Projected Future Climatic Conditions for Ecoregions and Selected Natural Heritage Areas in Ontario
CCRR-16
Ontario

1. Ecoregions, ecologically and geographically distinct areas that are smaller than an ecozone and larger than an ecosystem

2. Natural heritage areas, a diverse network of sites (national/provincial parks, migratory bird sanctuaries, wildlife management areas, etc.) that are protected to help conserve biodiversity

In 2010, a team of Canadian Forest Service-Great Lakes Forestry Centre (CFS-GLFC) and MNR researchers was asked to determine how climate envelopes will shift for Ontario's ecoregions and natural heritage areas. They have presented their results in an MNR Climate Change Research Report entitled *Current and Projected Future Climatic Conditions for Ecoregions and Selected Natural Heritage Areas in Ontario*.

This report spotlights the current climate envelope for Ontario's 14 ecoregions and 29 natural heritage areas, as well as what's expected for three future periods: 2011-2040, 2041-2070, and 2071-2100. It also presents the current/expected climate envelopes for 12 common Ontario trees to give resource managers an idea of how climate change could affect individual species.

"We found that based on current climate models, Ontario's ecoregions and natural heritage areas will face major climatic changes over the next century," says OFRI research scientist Steve Colombo, a member of the research team and a coauthor of the report. "Generally speaking, the climate envelopes for these areas are expected to move north, become smaller and more scattered, or even disappear."

Research team leader Dan McKenney of the CFS-GLFC points out that over this century, the annual mean temperature in Polar Bear Provincial Park could increase from -4.5 degrees C. to nearly +2 degrees C. "The park's climate could be more suitable for sugar maple than polar bears!"

Similar changes are expected for most of the rest of Ontario.

Continued on next page

Ask the **EXPERT**

Q. *What kind of forest resources inventory (FRI) information do we need to manage Great Lakes-St. Lawrence forests?*

A. *OFRI hardwood ecosystem research scientist Trevor Jones, who is studying use of lidar for hardwood FRI, responds:*

In Ontario's Great Lakes-St. Lawrence Forest, those who decide how forests will be managed need accurate, scientifically defensible information to ensure their plans and actions meet the requirements of all relevant policy and legislation and the ministry's goal of ecological sustainability.

Managers must follow policy that operates at varying scales – ranging from the tree marking guide at the individual tree and stand levels to the *Crown Forest Sustainability Act*, the *Policy Framework for Sustainable Forests*, and the *Forest Management Guide for Great Lakes-St. Lawrence Landscapes* at the landscape scale, with many others applied in between. Their information needs are diverse and complex.

For example, at the harvest block level, forest managers need to know with some certainty the species composition, distribution of tree sizes, total biomass/volume, volumes by species and size class, proportion of merchantable vs. recoverable volumes resulting from different harvest systems and stand types, and proportion of *acceptable* vs. *unacceptable* growing stock based on tree health and form.

At the forest management unit and landscape levels, they need to be able to identify protected areas that meet the structural and species compositional targets for wildlife habitat; to locate areas to harvest that meet stakeholder needs for volume, composition, and quality; and to ensure that local supply needs are met over the short, medium, and long term.

In Ontario, FRI data are now acquired via Airborne Digital Sensor (ADS40) photography. Interpreters use this very high-quality, high-resolution imagery along with some ground sampling to recognize and describe species composition and stocking. Ontario's FRI is a strategic level inventory, based on human interpretation of stands and species composition, ecosite and site index, average stand height, and age. Accurately determining these stand level attributes even from high resolution imagery is difficult, and systematic errors in classification are common, particularly in Great Lakes-St. Lawrence forests. In addition, the current FRI does not provide detailed estimates of forest structure and volume that are needed for current decisionmaking.

So how can research help? By improving inventory information produced at the stand level, we can help ensure better decisions and improved modelling at higher scales.

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The researchers stress that to ensure resource managers can make meaningful decisions for managing Ontario's natural resources over the coming century, the frameworks used to manage ecoregions and natural heritage areas must account for expected climate change.

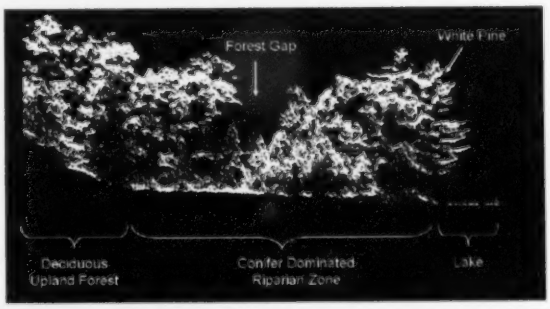
Other researchers involved in this work were John Pedlar and Kevin Lawrence of CFS-GLFC; Paul Gray, MNR's Applied Research and Development Branch; and Bill Crins, MNR's Parks and Protected Areas Policy Section. To get a copy of the report (Climate Change Research Report CCRR-16), contact information.ofri@ontario.ca, (705)946-2981, ext. 4111.

Over the past decade, research has shown that using remote sensing (such as ADS40 and lidar, which uses a laser mounted on aircraft to produce images of items such as forests and trees on the Earth's surface) and new methods of individual tree classification (ITC) and lidar metrics can enhance our ability to acquire forest biophysical and ecological variables for forest planning and operations. These technologies and methods are starting to be used operationally in forests around the world but typically in even-aged forests with low species diversity.

In Ontario, we are now investigating how to improve inventory in hardwood stands in the Great Lakes-St. Lawrence forest by supplementing the standard ADS40 imagery with lidar images. We are still in the early stages of our work, but the data look promising. We believe that adding lidar to the standard soft-copy forest photo-interpretation inventory will:

- Help photo-interpreters more accurately determine species composition, including rare and endangered species
- Provide data on important biophysical attributes (volume, tree size distribution, etc.) at small (0.25 hectare) scales, which can be combined to better represent stand level species composition, volume, and stand structure at the forest and landscape scales
- Identify critical wildlife habitat, such as certain species groupings or structural attributes that meet the needs of key wildlife species (for example, large patches of closed-canopy hemlock forest, used as cover by deer in the winter)
- Provide better data for estimating stored carbon in Great Lakes-St. Lawrence forests
- Provide better information about initial stand conditions for growth and yield modelling
- Allow estimates of the reliability of FRI data
- Reduce forest management planning costs and increase profitability by not allocating stands for harvest that do not meet criteria for species composition and volume

Stay tuned....We hope to start presenting results in late winter or early spring 2011.



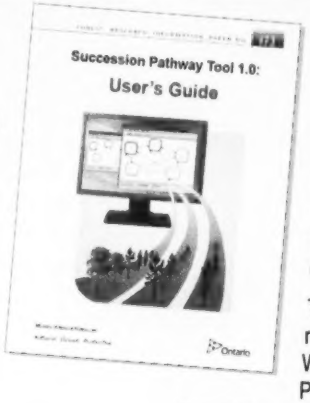
Lidar imagery provides information about forest structure and volume that is not available via traditional forest resource inventory.

Visit ontario.ca/ofri to see more lidar images!

Got/want forest succession knowledge? Then this tool is for you

By Abigail M. Obenchain

Users of forest succession knowledge take note: A tool is available to help you capture, visualize, and explore its emerging properties using aspatial simulations. Entitled *Succession Pathway Tool*, this software allows you to document your succession knowledge and share it with others.



How could this tool be used? Forest managers might want to project future forest states for a given area based on succession knowledge. Before investing time and money in forest dynamics simulation modelling, they might want to confirm that their expression of forest succession knowledge reflects the expected succession pathway – especially when converting qualitative knowledge to quantitative form for the model. This tool is also useful for researchers who wish to gather knowledge about forest succession from several individuals in a standardized way or to capture their own succession knowledge for use in other modelling tools.

What's more, researchers designed the Succession Pathway Tool to work well with the Boreal Forest Landscape Dynamics Simulator (BFOLDS). To run BFOLDS, you need correctly formalized information about succession, and the Succession Pathway Tool can generate that.

To use the Succession Pathways Tool, you must have a strong knowledge of forest succession and understand its basic premises and assumptions. One assumption is that forests consist of relatively homogenous spatial units that can be classified by their species composition into discrete, non-overlapping forest cover types. The tool does not account for spatial interactions among units; while these units do interact spatially, that is a function for complex, spatially explicit forest simulation models to delve into.

The Succession Pathway Tool was developed by researchers Michael Drescher (now with the University of Waterloo) and Marc Ouellette under the guidance of Ajith Perera. To download this tool or the user's guide (OFRI Forest Research Information Paper No. 173), visit the Forest Landscape Ecology Program website at fire-regime-model.com.

OFRI STAFF NEWS

Since our last issue....

MNR's Applied Research and Development Branch has welcomed a new director, **Anne Neary**, who comes to MNR from the Ministry of the Environment (MOE), where she was director of the Southwest Region, Operations Division. She was responsible for compliance and abatement activities as well as applied science to support these activities and issue approvals. She also worked in MOE's Environmental Science and Standards Division. She has an MSc in soil science from the University of Western Ontario. As director of MNR's Applied Research and Development Branch, she leads the ministry's four research sections, covering forest, aquatic, and wildlife research, as well as MNR's Climate Change Office. Anne replaces **Cheryl Lewis**, who retired in spring 2010.

Jim Rice has left OFRI after working in MNR forest research for more than 25 years, first in Maple and since 1990 in Sault Ste. Marie. He says he looks back most fondly on co-authoring the province's first hardwood tree marking guide (with research scientist emeritus Harvey Anderson), launching and conducting a major research project on stand level adaptive management in boreal mixedwood forests (with now-retired research scientist Blake MacDonald and others), and working with many fascinating, dedicated, and talented people over his research career. He is now the forest management guides forester with MNR's Forest Policy Section, where he is implementing the new *Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales.*

Wenbin Cui has also moved from OFRI to the MNR offices at Bondar Place in the Sault. At OFRI he was a senior landscape ecology analyst with the Forest Landscape Ecology Program, working on forest fire growth modelling and spatio-temporal analysis as well as BFOLDS, the Boreal Forest Landscape Dynamics Simulator. He is now a forest modelling specialist with MNR's Forest Management Planning Section.

Francis Tang, tree improvement data analysis with OFRI since 2005, has left MNR to pursue a career in data analysis and computer programming in Toronto. He provided expert analysis and database management support primarily to Forest Genetics Ontario and MNR's Forest Health and Silviculture Section. Francis says he misses working with his colleagues in tree improvement, and he thanks his coworkers for their support and kindness.

Maara Packalen, the chemical lab technologist in OFRI's biochemistry lab, has left OFRI for an educational leave. She is working on her PhD at the University of Toronto.

Have a suggestion?

Want more information on a research project?

We want to hear from you!

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